

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Original) An electro-active actuator having a bender construction comprising layers of electro-active material and electrode layers for activation of the electro-active material, the layers of electro-active material being shaped to extend continuously along at least one curved portion and at least one substantially flat portion arranged with electrical terminals for electrical connection to the electrode layers.
2. (Original) The electro-active actuator of claim 1, wherein the curved portion forms a helix arranged, on actuation, to bend around the axis of the helix.
3. (Original) The electro-active actuator of claim 2, wherein the helix formed by the curved portion is itself curved.
4. (Currently Amended) The electro-active actuator of ~~any one of the preceding claims~~claim 1, wherein the flat portion extends tangentially from the curved portion.
5. (Currently Amended) The electro-active actuator of ~~any one of the preceding claims~~claim 1, wherein the flat portion has a length equal to or exceeding an outer diameter of the curved portion.
6. (Currently Amended) The electro-active actuator of ~~any one of the preceding claims~~claim 1, wherein the electrical terminals are located on the same face of the flat portion.

7. (Currently Amended) The electro-active actuator of ~~any one of the preceding claims~~claim 1, wherein the electro-active material is a ceramic material.

8. (Currently Amended) The electro-active actuator of ~~any one of the preceding claims~~claim 1, wherein the substantially flat portion is arranged as a projecting tab.

9. (Canceled).

10. (Currently Amended) A method of manufacturing an electro-active actuator according to ~~any one of the preceding claims~~having a bender construction comprising layers of electro-active material and electrode layers for activation of the electro-active material, the layers of electro-active material being shaped to extend continuously along at least one curved portion and at least one substantially flat portion arranged with electrical terminals for electrical connection to the electrode layers, the method comprising:

preparing a ceramic tape in a green state;

placing said tape into a former having a section to support said flat portion and maintain the orientation of said flat portion with respect to the permanently curved portion of the actuator; and

drying said tape within said former to reduce the plasticity of said tape.

11. (Original) The electro-active actuator of claim 1, comprising a single curved portion curving around an axis and arranged, on actuation, to bend around the axis, and at least one flat portion extending away from the axis.

12. (Original) The electro-active actuator of claim 11, wherein the curved portion has a substantially uniform shape parallel to the axis.

13. (Currently Amended) The electro-active actuator of claim 11-~~or~~-12, wherein the flat portion extends radially away from the axis.

14. (Currently Amended) The electro-active actuator of ~~any one of claims~~claim 11-~~to~~-13, wherein the curved portion has a cross-section perpendicular to the axis which is substantially a section of a circle.

15. (Currently Amended) The electro-active actuator of ~~any one of claims~~claim 11-~~to~~-14, wherein ~~the layers of electro-active material being shaped to extend continuously from the first mentioned curved portion~~ has a first part curving around said axis and a second part extending from the first part to said straight portion ~~along a second curved portion~~and having a curvature of opposite sign from said first curved portion.

16. (Currently Amended) The electro-active actuator of ~~any one of claims~~claim 11-~~to~~-15, wherein the electroactive material is a ceramic material.

17.-20. (Canceled).

21. (Currently Amended) A loudspeaker for audible sound comprising a sound emitting element mounted onto a support structure and at least one actuator as claimed in ~~any one of claims~~claim 11-~~to~~-20 being mounted at a proximate edge onto said sound emitting element and a distal edge onto said support structure.

22. (Original) The loudspeaker of claim 21 having a compliant sealing element or elements around the edges of the sound-emitting element.

23. (Currently Amended) The loudspeaker of claim 21 or 22, wherein the second flat section with the distal edge is mounted onto a part of the support structure while the first curved section with the proximate edge is mounted onto the sound-emitting element such that said curved section bridges a gap between said sound emitting element and said support structure.

24. (Currently Amended) The loudspeaker of ~~any one of claims~~claim 21 to 23, wherein the support structure and the sound generating element are parts of the outer shell of a portable data handling or communication device.

25. (Currently Amended) The loudspeaker of ~~any one of claims~~claim 21 to 24, wherein the second flat section extends in a longitudinal direction into a rectangular shape.

26. (Currently Amended) The loudspeaker of ~~any one of claims~~claim 21 to 25, wherein the second flat section terminates as two or more flat portions.

27. (Original) The electro-active actuator of claim 1, comprising a single curved portion and two flat portions extending tangentially from opposite ends of the curved portion, at least one of which is arranged with said electrical terminals for electrical connection to the electrode layers.

28. (Original) The electro-active actuator of claim 27, wherein the two flat portions are substantially parallel to each other.

29. (Currently Amended) The electro-active actuator of claim 27-~~or 28~~, wherein the straight portions are each arranged, on actuation, to bend in a sense opposite from the curved portion.

30. (Currently Amended) The electro-active actuator of claim 27-~~or 28~~, wherein the straight portions are each poled in a direction opposite from the direction in which the curved portion is poled.

31.-32. (Canceled).

33. (Currently Amended) A loudspeaker for audible sound comprising a sound emitting element mounted onto a support structure and at least actuator as claimed in ~~any one of claims~~claim 27 to 32 being connected to said sound emitting element and a support, wherein the sound emitting element is connected to an end portion of one of the flat portions and the actuator is mounted with an end portion of the other flat portion connected to the support.

34. (Original) The loudspeaker of claim 33 having a compliant sealing element or elements around the edges of the sound-emitting element.

35. (Currently Amended) The loudspeaker of claim 33-~~or 34~~, wherein sound emitting element is a flat or slightly curved transparent panel.

36. (Currently Amended) The loudspeaker of ~~any one of claims~~claim 33 to 35, wherein the support structure and the sound generating element are parts of the outer shell of a portable data handling or communication device.

37. (Currently Amended) A method of manufacturing an electro-active actuator ~~in accordance with any one of claims 27 to 32~~ having a bender construction comprising layers of electro-active material and electrode layers for activation of the electro-active material, the layers of electro-active material being shaped to extend continuously along a single curved portion and two substantially flat portions extending tangentially from opposite ends of the curved portion, at least one of the flat portions being arranged with said electrical terminals for electrical connection to the electrode layers, the method comprising:

manufacturing deformable sheets of pre-cursor material;

applying a first, a second and a third electrode onto the sheets;

stacking said sheets such that at least one first, second and third electrode overlay to form a layer of bimorph tape;

pressing the bimorph tape into the shape of the actuator; and

sintering the shaped tape,

wherein two of the three electrodes have gaps at locations corresponding to areas between adjacent sections of the actuator and one of the three electrode is continuous across the areas.

38. (Original) The method of claim 37, further comprising the step of poling the straight portions of the actuator oppositely to the curved portions.

39. (Original) The electro-active actuator of claim 1, wherein the curved portion forms a helix arranged, on actuation, to bend around the axis of the helix, which helix is

itself curved to have two sections of opposite curvature with rotational symmetry about the point between the two sections.

40. (Original) The electro-active actuator of claim 39, comprising a single curved portion.

41. (Original) The electro-active actuator of claim 40, including a said flat portion arranged with electrical terminals for electrical connection to the electrode layers at one end of the curved portion.

42. (Original) The electro-active actuator of claim 41, including a further substantially flat portion at the other end of the curved portion.

43. (Original) The electro-active actuator of claim 42, wherein said further flat portion at the other end of the curved portion is arranged with electrical terminals for electrical connection to the electrode layers.

44. (Currently Amended) The electro-active actuator of claim 42-~~or~~43, wherein the actuator is mounted to a first object at said point between the two sections and to a second object by said first mentioned flat portion and said further flat portion.

45. (Currently Amended) The electro-active actuator of ~~any one of claims~~ claim 39-~~to~~44, wherein said two sections of opposite curvature are substantially sections of a circle.

46. (Original) An electro-active device having a continuous electro-active member extending along a minor axis which is curved, the continuous electro-active member curving around the minor axis and arranged with electrodes to bend, on activation, around the minor axis, thereby to twist around the minor axis concomitantly with relative displacement of portions of the device out of the plane of the curve, wherein the minor axis follows a curve having two sections of opposite curvature with rotational symmetry about the point between the two sections.

47. (Original) The electro-active actuator of claim 46, wherein the continuous electro-active member curves around the minor axis in a helix.

48. (Currently Amended) The electro-active actuator of claim 46 or 47, wherein the minor axis follows a curve having a single change in curvature at said point between the two sections.

49. (Currently Amended) The electro-active actuator of ~~any one of claims~~claim 46 to 48, wherein the actuator is mounted to a first object at said point between the two sections and to a second object at the opposite ends of said two sections.

50. (Currently Amended) The electro-active actuator of ~~any one of claims~~claim 46 to 49, wherein said two sections of opposite curvature are substantially sections of a circle.

51. (Original) An electro-active actuator adapted to move objects in a straight line, said actuator having at least one group of coupled actuator sections with each of said sections having a structure of electro-active material extending around a minor axis which is permanently curved and wherein the structure of electro-active material

includes successive electro-active portions having electrodes to bend, when activated, around the minor axis, and said sections being coupled by a joint element and arranged in a rotational symmetry about said joint element.

52. (Original) The electro-active actuator of claim 51, wherein the actuator sections within each group move, when activated, parallel to one another while balancing out motions in other directions.

53. (Currently Amended) The electro-active actuator of claim 51-~~or~~-52, wherein the actuator sections within each group are essentially identical.

54. (Currently Amended) The electro-active actuator of ~~any one of claims~~claim 51-~~to~~-53, wherein each section comprises a continuous electro-active element extending along and curving around the minor axis.

55. (Original) The electro-active actuator of claim 54 wherein the continuous electro-active element curves around the minor axis as a helix.

56. (Currently Amended) The electro-active actuator of ~~any one of claims~~claim 51-~~to~~-55, having at least two actuator sections of opposite curvature coupled by the joint section.

57. (Currently Amended) The electro-active actuator of claim 55~~56~~, wherein the two actuator sections of opposite curvature are formed from one continuous tape of electro-active ceramic material.

58. (Original) The electro-active actuator of claim 57, wherein the two actuator sections and the joint section are formed from one continuous tape of electro-active ceramic material.

59. (Currently Amended) The electro-active actuator of ~~any one of claims~~claim 51 ~~to~~ 56, wherein the joint section comprises a hetero material.

60. (Original) The electro-active actuator of claim 59, wherein the joint section is adapted to be relatively stiff in all but one direction.

61. (Currently Amended) The electro-active actuator of ~~any one of claims~~claim 51 ~~to~~ 60, wherein all actuator sections within one group are adapted to receive essentially identical activation signals.

62. (New) The electro-active actuator of claim 1, wherein the layers of electro-active material comprises sintered electro-active material.

63. (New) The electro-active actuator of claim 1, comprising a single curved portion and either a single flat portion at one end of the curved portion or a respective flat portion at each end of the curved portion.